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ABSTRACT

This unit is part of the Understanding Our Environment project that is designed to engage students in investigating specific environmental problems through concrete activities and direct experience. Students begin by researching the migratory songbirds that live in their community. They determine the bird's roles in the ecosystems and their requirements for survival. The investigations explore the importance of energy, cycles, and organism interactions in maintaining a stable system. The unit concludes with students using their new knowledge to create a wildlife habitat at their school or homes to study these birds and other wildlife. Objectives include: learning which migratory birds are in the neighborhood and where they go for the rest of the year, examining the role of a local migratory bird in each of its ecosystems, understanding the concept of a food web, exploring the flow of energy through ecosystems, learning about the cycling of matter through the environment, understanding the interdependence of living things and the importance of biodiversity to ecosystems, relating human activities to quality of the environment, and observing the interactions of birds and other wildlife by creating or improving a habitat at school or home. (JRH)

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LIFE

Laura M. Sanders Arndt

This publication is dedicated to Dr. Alan L. McClelland for his many years of devoted work at DuPont, in the government, and in the community to develop and educate people of all ages in mathematics, engineering, and chemistry. His commitment to advancing the understanding of the sciences has influenced thousands of lives and careers around the world.

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Envelope contents for this unit:
Bird Migration in the Americas, National Geographic Society
Common Feeder Birds, Cornell Lab of Ornithology

Cover: Photograph of a mountain bluebird, by A. Biale, Cornell Lab of Ornithology

Laura M. Sanders Arndt teaches environmental science and outdoor naturalist classes at Eaglecrest High School in the Cherry Creek School District in Aurora, Colorado.

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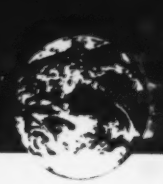

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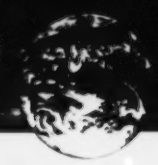

Where Have All the Songbirds Gone?

Many species of migratory songbirds are not as numerous as they used to be. Bird populations are often key indicators of the health of a natural system from as far north as the arctic tundra to the southern tip of Argentina. Threats to bird populations could occur in a species' summer range, its migration route, or its winter range.

To begin to unravel the mystery of the actual and potential disappearance of some songbirds, one must have a thorough understanding of ecosystem dynamics. Students will begin by researching the migratory songbirds that live in their community. They will determine the birds' roles in the ecosystems and requirements for survival. Investigations will explore the importance of energy cycles, and organism interactions in maintaining a stable system. Finally, students will use their new knowledge to create a wildlife habitat at their school or homes to study these birds and other wildlife.

Objectives

- Learn which migratory birds are in the neighborhood and where they go for the rest of the year.
- Examine the role of a local migratory bird in each of its ecosystems.
- Understand the concept of a food web.
- Explore the flow of energy through ecosystems.
- Learn about the cycling of matter through the environment.
- Understand the interdependence of living things, and the importance of biodiversity to ecosystems.
- Relate human activities to quality of environment.
- Observe the interactions of birds and other wildlife by creating or improving a habitat at school or home.

Project Part 1: Who's in Our Neighborhood?

Students begin their investigation of migratory songbirds (or birds in general) by identifying which species visit their community, determining where these birds go at other times of year, and examining the birds' roles in each ecosystem. While students conduct this research outside of class for two days, in class they pursue the next activity and learn about food webs. They will organize what they have learned and share that knowledge with the class.

Throughout this unit, students consider ecological themes in the context of birds' requirements for survival. In Part 1 of the project, students acquire the knowledge they will need in Part 2 to create a place for birds, a habitat, on the school grounds or in their own yard so they can observe the birds firsthand.

Plan Ahead for Project Part 2

Project Part 2 will require advance planning. After the bird habitat is set up, there may be a waiting period while birds discover their new food source and students pursue related activities.

Teaching Notes

Time Required: This part of the project requires three or four class periods: two periods for research (with a two-period break while students continue research and the class completes the next activity), then one or two periods for presentations and summarizing.

Grouping: Students may work in cooperative groups or individually. If working individually, the student may focus on all or part of the bird's migratory pattern (summer range, migration routes, winter range), depending upon the amount of information available on the particular bird.

Migratory Songbird Choices

Orioles, thrushes, tanagers, warblers, swallows, hummingbirds, vireos, flycatchers, buntings, sparrows, and grosbeaks are among the migratory songbirds. Determine

American goldfinch, a neotropical migrant, feeding its young.

which species in these groups visit your community.

To increase the choice of birds to research, you may want to include other migratory birds, such as shorebirds and raptors.

Information on songbird species will vary widely. Some have been studied for years, while little or no research has been done on others. Much information is available on some species of migratory raptors, water fowl, and shorebirds. Contact local birding experts to help in information gathering when possible.

Issue Summary

Before Research. After students read the introductory material, have them answer the following questions as part of a class discussion or individual assignment.

1. Describe the issue in your own words.
2. What is happening—naturally or as a result of human activities—in the United States that might threaten bird populations?
3. What is happening—naturally or as a result of human activities—in Mexico, Central America, Canada, and the Arctic that might threaten bird populations?
4. What solutions may help reduce these threats?
5. What types of information might you need to help you understand the issue and think of ways to try to stabilize migratory songbird populations?

After Research. During presentations, students should record the results of all groups on a chart with the following headings: Bird Species; Summer Range, Migration Routes, Winter Range; Biomes and Ecosystems; Nonfood Requirements; Food Sources; Level in Food Chain; Human Threats; Solutions to Threats.

Technological Connections

Students can use a variety of technologies for their posters and presentations: Hypercard or Hyperstudio software; draw, paint, or clip-art software; videotape; and photographs or graphics of habitats, biomes, and species from laser discs or CD-ROMs.

Assessment Options

1. Have students submit three to five specific questions about their group's presentation (for example, "What is one threat to the yellow-headed blackbird in its winter range?"). Include selected questions on an open-note and display quiz for the class.

2. Have students determine the implications of the combined findings and explain any similarities, trends, and distinctions.

Extension

Students can research other migratory birds from similar latitudes or species in the Eastern Hemisphere.

References and Resources

Adam George. (1995). *Birdscaping Your Garden*, Emmaus, PA: Rodale Books.

"Bird Migration in the Americas." (1979). National Geographic Society, Washington, D.C. (Map in the envelope)

Field guides to birds (see Resources, p. 51).

Knickerbocker, Brad. (1994, February 15). Stopping the Flight to Extinction. Christian Science Monitor, pp. 10–11.

Female (left) and male rufous-sided towhees at nest.

Suggested Resources

(See Resources, p. 51)

- Project FeederWatch, Cornell Lab of Ornithology
- Birds in the Balance Campaign, National Audubon Society
- Backyard Wildlife Habitat Program, National Wildlife Federation
- Partners in Flight, National Fish and Wildlife Foundation

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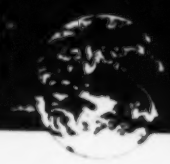
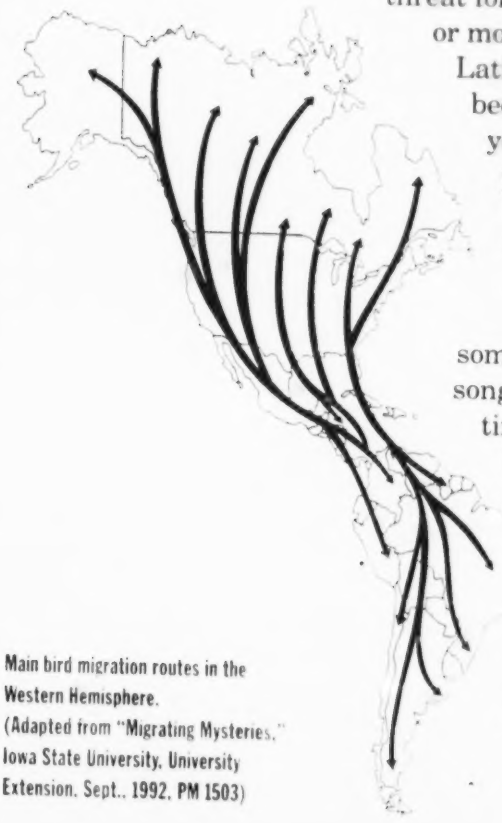


Who's in Our Neighborhood?

Millions of migratory birds, including 300 to 400 species of neotropical songbirds, stake out territory in the United States along some point in their migration route. Many species that summer in the tundra and taiga of Canada and Alaska head south to the warmer United States for the winter. Most songbirds that spend the spring and summer months here migrate south to spend the colder months in the neotropics of Mexico, Central America, the Caribbean, and South America. The U.S. Fish and Wildlife Service has reported that 70 percent of the populations of neotropical bird species that summer in the eastern United States have declined over the past decade. Biodiversity expert E. O. Wilson estimates that one fifth of bird species worldwide have vanished!

Specific threats to songbird species vary from community to community. Yet, some trends are clear. The primary threat for most species is loss of required habitat in one or more of their migratory stops. For example, in Latin America and the Caribbean, forests have been disappearing at a rate of 2 to 4 percent per year. Other threats to songbirds include parasitic cowbirds invading songbird nests; killings by domestic, feral, or wild animals; the wild bird trade; pesticide poisoning; and even human consumption of songbirds.

Although almost every species is declining in some part of this country, most species of songbirds are still common. The most effective time to help any species is long before it becomes endangered. Efforts are being made to protect undisturbed habitats and migratory corridors from one habitat to another. Controls on pesticide use continue to be evaluated. Educating people worldwide on the essential role songbirds play in all ecosystems can help lessen other threats to bird populations.

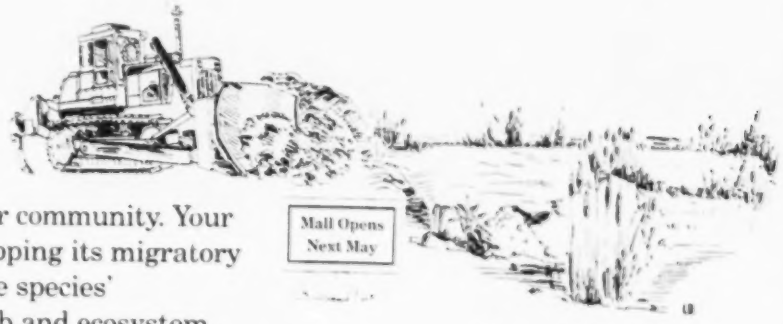


Main bird migration routes in the Western Hemisphere.
(Adapted from "Migrating Mysteries," Iowa State University, University Extension, Sept., 1992, PM 1503)

Your goal in this unit is to unravel the mysteries of the appearance and potential disappearance of songbirds that are a part of your community. To do this, you will need to find out which species visit your neighborhood, determine what keeps them coming back year after year, and finally, in Part 2 of this project, offer some birds a place, or habitat, in your own yard or at school.

Task

In cooperative groups, you will research a particular migratory songbird or other bird that visits your community. Your research will involve mapping its migratory patterns, determining the species' importance to its food web and ecosystem, explaining the present human threats to the species' survival, and finally, proposing solutions for reducing these human threats.



A bulldozer fills a wetland for development. Loss of habitats like marshes and forests is a major threat to migrating birds.

Choosing a Bird

During the time period specified by your teacher, list the names or descriptions of birds you see around your home, school, and neighborhood. Watch the birds and notice what they are eating.

Then, as a class, compile a list of migratory songbirds that visit your community. (Sources of information and bird lists include: museums and nature centers; the local Audubon Society; ornithology group; informal birding groups; wildlife or environmental group; your state's wildlife agency; local, state, and national parks; and U.S. Forest Service.)

Next, in cooperative groups, choose a bird species from the list to research. Each group should study a different bird. Each group will create a poster to display the results of their investigation.

The Research

Assign research responsibilities within your group for these three categories: Summer Range, Migration Routes,

and Winter Range. Then complete the research for your category as follows:

A. On a map your group will prepare for a poster (see below), mark the bird's actual or likely summer range, migration routes, and winter range. Show the waterways, regions, and countries through which the bird travels.

B. Diagram and describe the bird's food web in your research area. Include any other requirements for the bird's survival. Describe the biome in which the bird lives (climate, dominant plants).

C. Explain any human threats to this species in your research area.

D. Describe ways people are trying to reduce human and nonhuman threats in your research area. You may want to propose ways to help these birds survive.

Presentation and Summary

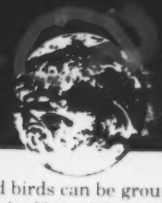
Mountain bluebird

As a group, create a poster to display the information you have gathered. The poster should include:

1. An individualized title and the names of group members.
2. A drawing of the bird.
3. A drawing of the Western Hemisphere with the bird's range indicated (the results of Part A, above).
4. Labeled sections with the rest of the required information in each research area.

Mountain bluebird ranges: summer (squares), year-round (dots), winter (stripes).

Your group may also present a five-minute summary of their findings. After the presentations, the posters will be on display. You will then study all of the results to determine similarities and differences among species and record the information on a chart with these headings: Bird Species; Summer Range, Migration Route, Winter Range; Biomes and Ecosystems; Nonfood Requirements; Food Sources; Level in Food Chain; Human Threats; Solutions to Threats.



MIGRANTS FOR PARTNERS IN FLIGHT NEOTROPICAL MIGRATORY BIRD CONSERVATION PROGRAM

Migrant land birds can be grouped by the areas where they breed and winter. In List A are species that breed in North America and winter mostly south of the United States–the neotropical migrants. Some fly as far as southern South America for their nonbreeding time (Northern Hemisphere winter). List B names species that breed and winter in North America. In List C are species that breed in Mexico and southern Texas. List D names tropical species that breed only on the Florida peninsula.

List A

American Swallow-tailed Kite
Mississippi Kite
Broad-winged Hawk
Swainson's Hawk
Merlin
Peregrine Falcon
Mountain Plover
Upland Sandpiper
Long-billed Curlew
Band-tailed Pidgeon
Black-billed Cuckoo
Yellow-billed Cuckoo
Flammulated Owl
Burrowing Owl
Lesser Nighthawk
Chuck-will's-widow
Whip-poor-will
Black Swift
Chimney Swift
Vaux's Swift
White-throated Swift
Ruby-throated Hummingbird
Black-chinned Hummingbird
Costa's Hummingbird
Calliope Hummingbird
Broad-tailed Hummingbird
Olive-sided Flycatcher
Western Wood-pewee
Eastern Wood-pewee
Yellow-bellied Flycatcher
Least Flycatcher
Hammond's Flycatcher
Dusky Flycatcher
Gray Flycatcher
Pacific-slope Flycatcher
Cordilleran Flycatcher
Vermillion Flycatcher
Ash-throated Flycatcher
Great Crested Flycatcher
Western Kingbird
Eastern Kingbird
Scissor-tailed Flycatcher
Purple Martin
Violet-green Swallow
Northern Rough-winged Swallow
Bank Swallow
Cliff Swallow
Barn Swallow
House Wren
Blue-gray Gnatcatcher
Veery
Gray-cheeked Thrush
Wood Thrush
Gray Catbird
Phainopepla
White-eyed Vireo
Bell's Vireo
Black-capped Vireo
Gray Vireo
Solitary Vireo
Yellow-throated Vireo
Warbling Vireo
Philadelphia Vireo
Red-eyed Vireo
Bachman's Warbler
Blue-winged Warbler
Golden-winged Warbler
Tennessee Warbler
Orange-crowned Warbler
Nashville Warbler
Virginia's Warbler
Northern Parula Warbler
Yellow Warbler
Chestnut-sided Warbler
Magnolia Warbler
Cape May Warbler
Black-throated Blue Warbler
Black-throated Gray Warbler
Townsend's Warbler
Hermit Warbler
Black-throated Green Warbler
Golden-cheeked Warbler
Blackburnian Warbler
Yellow-throated Warbler
Grace's Warbler
Kirtland's Warbler
Prairie Warbler
Palm Warbler
Bay-breasted Warbler
Blackpoll Warbler
Cerulean Warbler
Black-and-white Warbler
American Redstart
Prothonotary Warbler
Worm-eating Warbler
Swainson's Warbler
Ovenbird
Northern Waterthrush
Louisiana Waterthrush
Kentucky Waterthrush
Connecticut Warbler
Mourning Warbler
MacGillivray's Warbler
Common Yellowthroat
Hooded Warbler
Wilson's Warbler
Canada Warbler
Yellow-breasted Chat
Hepatic Tanager
Summer Tanager
Scarlet Tanager
Western Tanager
Rose-breasted Grosbeak
Black-headed Grosbeak
Blue Grosbeak
Lazuli Grosbeak
Indigo Bunting
Painted Bunting
Dickcissal
Green-tailed Towhee
Chipping Sparrow
Clay-colored Sparrow
Brewer's Sparrow
Black-chinned Sparrow
Lark Sparrow
Lark Bunting
Baird's Sparrow
Grasshopper Sparrow
Lincoln's Sparrow
Bobolink
Yellow-headed Blackbird
Orchard Oriole
Hooded Oriole
Northern Oriole
Scott's Oriole

List B

Turkey Vulture
Northern Harrier
Shark-shinned Hawk
Cooper's Hawk
Northern Goshawk
Red-shouldered Hawk
Red-tailed Hawk
Ferruginous Hawk
Golden Eagle
American Kestrel
Prairie Falcon
Killdeer
Mourning Dove
Long-eared Owl
Short-eared Owl
Common Poorwill
Anna's Hummingbird
Belted Kingfisher
Lewis's Woodpecker
Red-naped Sapsucker
Yellow-bellied Sapsucker
Red-breasted Sapsucker
Williamson's Sapsucker
Northern Flicker
Eastern Phoebe
Say's Phoebe
Horned Lark
Tree Swallow
Brown Creeper
Rock Wren
Sedge Wren
Marsh Wren
Ruby-crowned Kinglet
Eastern Bluebird
Western Bluebird
Mountain Bluebird
Townsend's Solitaire
Hermit Thrush
American Robin
Northern Mockingbird
Sage Thrasher
Bendire's Thrasher
American Pipit
Sprague's Pipit
Cedar Waxwing
Loggerhead Shrike
Yellow-rumped Warbler
Rufous-sided Towhee
Cassin's Sparrow
Vesper Sparrow
Black-throated Sparrow
Sage Sparrow
Savannah Sparrow
Fox Sparrow
Song Sparrow
Swamp Sparrow
White-throated Sparrow
White-crowned Sparrow
Dark-eyed Junco
McCown's Longspur
Chestnut-colored Longspur
Red-winged Blackbird
Eastern Meadowlark
Western Meadowlark
Brewers' Blackbird
Brown-headed Cowbird
Pine Siskin
Purple Finch
Cassin's Finch
Lesser Goldfinch
Lawrence's Goldfinch
American Goldfinch

List C

Common Black-Hawk
Gray Hawk
Zone-tailed Hawk
White-winged dove
Grove-billed Ani
Elf Owl
Buff-colored Nightjar
Broad-billed Hummingbird
Buff-bellied Hummingbird
Violet-crowned Hummingbird
Blue-throated Hummingbird
Magnificent Hummingbird
Lucifer Hummingbird
Elegant Trogon
Green Kingfisher
Norther Beardless Tyrannulen
Greater Pewee
Buff-breasted Flycatcher
Dusky-capped Flycatcher
Brown-crested Flycatcher
Sulphur-bellied Flycatcher
Tropical Kingbird
Couches Kingbird
Thick-billed Kingbird
Rose-throated Becard
Cave Swallow
Collma Warbler
Lucy's Warbler
Red-faced Warbler
Painted Redstart
Olive Warbler
Varied Bunting
Botteri's Sparrow
Bronze Cow-bird

List D

White-crowned Pigeon
Mangrove Cuckoo
Antillean Nighthawk
Gray Kingbird
Black-whiskered Vireo

Source: BEST COPY AVAILABLE

National Fish and Wildlife Foundation: *Partners in Flight* newsletter (Vol. 2, No. 1, 1992)

A Web of Life for Neotropical Migrants

This activity introduces the concept of a food web, which is central to the various investigations in the unit and to an understanding of the balances necessary for maintaining a stable ecological system.

Students draw a food chain, expand it to a food web, and express the results in an energy pyramid. In the process, they consider what songbirds eat and learn why decomposers are a necessary part of the environment.

Teaching Notes

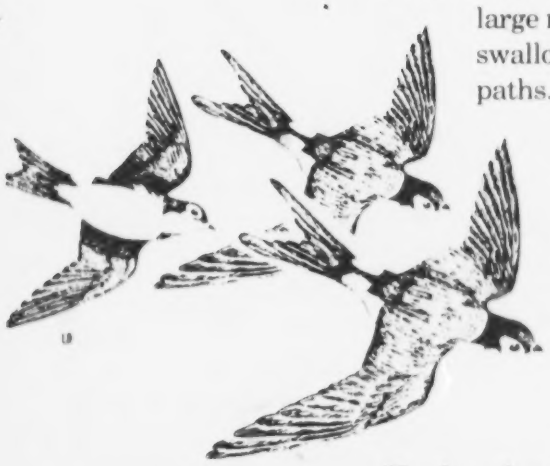
Time Required: This activity will normally take two class periods.

Extensions

1. Have students look up a local swallow in a bird field guide to see what it looks like. Point out that swallows have very large mouths. (Why?) Then have students identify the swallows' summer and winter ranges and migratory paths. Finally, have them go outside, preferably at twilight, to look for swallows that live in their community. (If they look closely, they might notice that feeding swallows fly with their mouths open to catch insects on the wing.)

2. Invite a local raptor rehabilitator or a falconer to speak to your class about migratory raptors.

3. Have student dissect and analyze owl pellets (available from science suppliers).



Violet-green swallows in flight.

Technological connections

1. Draw and illustrate the food web and pyramid on the computer using draw, paint, clip-art software.

2. Show students laser disc or CD-ROM pictures or videotapes of food-web interactions and of the animals described.

Resources

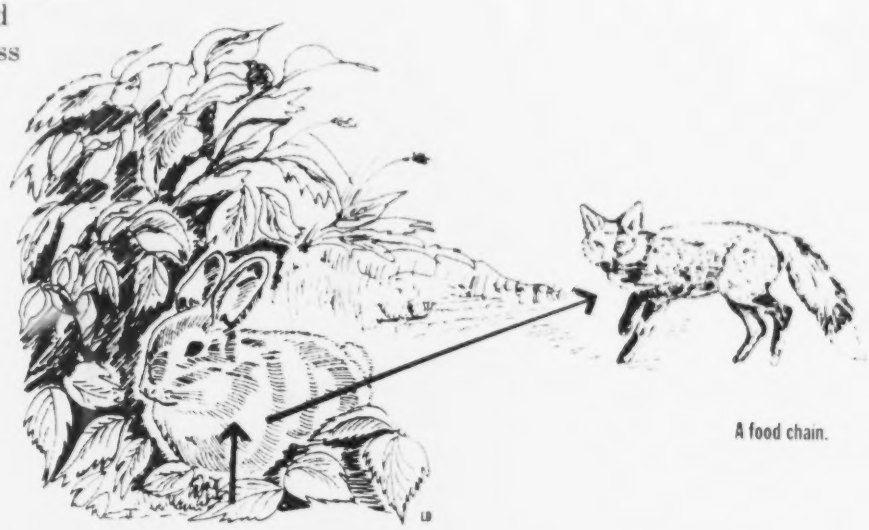
Field guides to birds (see Resources, p. 51).

A Web of Life for Neotropical Migrants

A **food chain** is a diagram that shows how food energy moves from one living organism to another. In reality, a simple food chain does not exist alone, but is a small part of a more complex system called a **food web**. A food web is part of an ecosystem's web of life, which also includes all of the **abiotic** (nonliving) needs of living organisms. Examples of abiotic needs include water for drinking or living in, and soil for homes. Can you think of others?

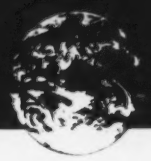
The steps of a food chain are:

1. All food chains and food webs begin with an original source of energy, usually the Sun.
2. Green plants use **solar**, or **radiant**, **energy** to convert water and carbon dioxide into their own food through the process of photosynthesis. Because plants make, or produce, their own food, they are called **producers**.
3. No animal can make its own food. All animals must consume (eat) plants or other animals to get energy.
4. An animal that eats plants is called a **primary consumer**, or **herbivore**.
5. An animal that eats a primary consumer is called a **secondary consumer**, or **carnivore**.
6. A carnivore that eats other carnivores is called a **tertiary consumer**, and so on.
7. Some animals, including most humans, eat both plants and animals. Members of this group are called **omnivores**.



A food chain.

ACTIVITY SHEET .: LIFE WEB OF LIFE

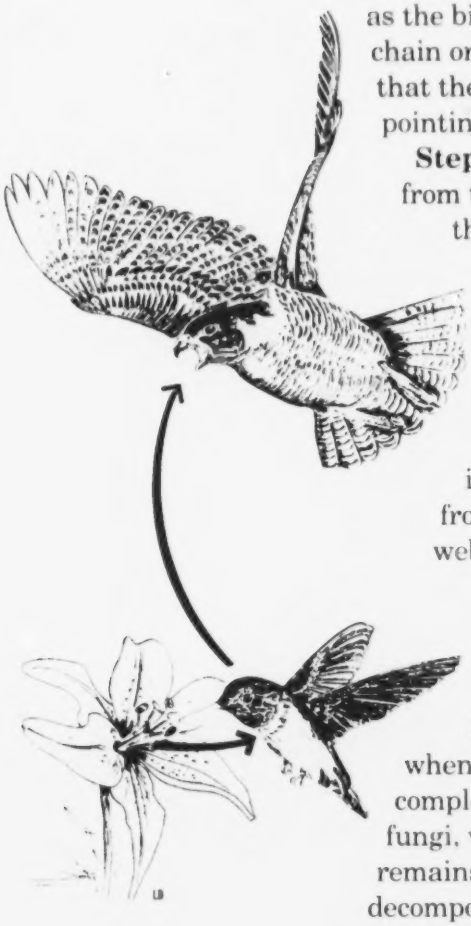


Task

In this activity you will read about a food chain that includes a neotropical migratory songbird and a migratory falcon. You will diagram a simple food chain that includes these two species. Next, you will expand your food chain into a food web to include other plant and animal species that share the same habitat and food supply. To finish your food web, you will add decomposers to complete the natural cycle of nutrients and flow of energy. Finally, you will draw an energy pyramid for the food chain that represents the movement of food energy through a food chain.

Creating the Web

Draw a food web that includes neotropical migrants, such as the birds in the example below. When drawing a food chain or web, make the arrows point in the direction that the food energy flows. Imagine that the arrow is pointing toward the mouth of the eater.



Step 1: Food Chain. Make a four-step food chain from these research results on two migratory birds: the most frequently taken prey of the peregrine falcon over an 11-year period was the insect-eating white-throated swift. (Many of the insects are plant eaters.) (From Gerald R. Craig, personal communication, November, 1994).

Step 2: Food Web. Read the paragraph "Life in the Meadow." Then add the plants and animals from the story to your food chain to create a food web. Add the producers first, then members of each higher level of the food chain. Show with arrows as many food-energy flow options as you can identify. Optional: Color-code each level of the food chain.

Step 3: Completing the Cycle. What happens when these plants and animals die but are not completely eaten for food? **Decomposers** (bacteria, fungi, worms, carrion beetles, flies) all feed on the remains of plants and animals that have died. Without decomposers, the regeneration of food-web nutrients would be impossible. The web would collapse! Decomposers

help recycle and alter nutrients, such as nitrogen, so that plants can use them to grow and, once again, take the Sun's energy and produce their own food through photosynthesis. And the web of life continues.

To one side of your food web, list the decomposers. Put a bracket around all levels of the food web, except decomposers. Then write a statement explaining the role of decomposers throughout the food web.

Life in the Meadow

As the Sun appears on the horizon on a cool spring morning, a great horned owl soars over a meadow in search of a meal. A bull snake, warming on a rock, freezes as the shadow passes, while a family of deer mice stops munching on fresh grass shoots and scurries into their nearest hole. The mice are wary of the snake, as well as the owl. The brown bats are already in their dark, deserted shed, an old miner's cabin preserved by local people for bat roosts. Their bellies are full from a feast of mosquitoes and other insects the night before. Mountain bluebirds and meadowlarks are scouring the meadow in search of plant seeds. The previous day, several of them barely escaped a chase by a peregrine falcon. Down below, a fritillary butterfly flutters silently among the wildflowers, sipping sweet nectar.

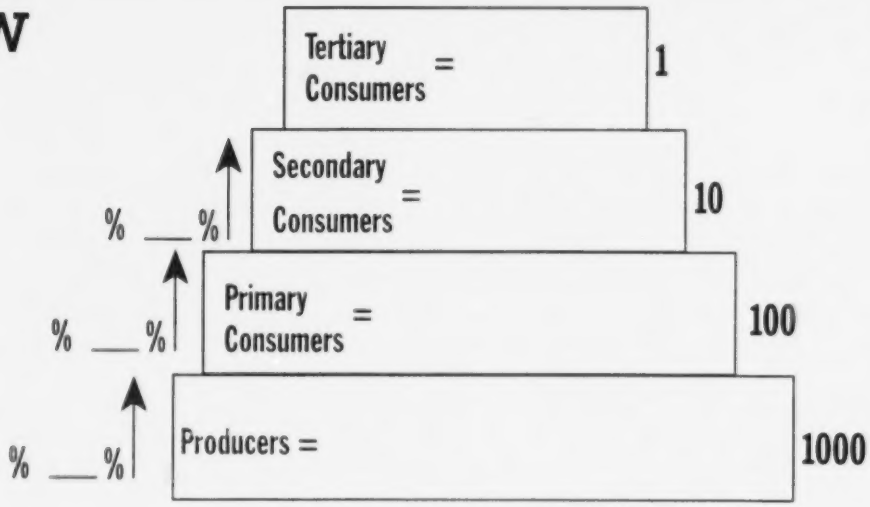
A new day dawns.

Step 4: Energy Pyramid. An energy pyramid diagram also can represent the movement of food energy through a food chain. The pyramid demonstrates the low amount of available energy (10 percent) that is transferred to the next level of the food chain. At each stage, 90 percent of the energy is lost to the environment in the form of heat. Organisms use most energy to breathe, move, and function throughout the day.

Fill in each level of the pyramid using the four plants and animals from the simple food chain that you made in Step 1. Write the percentages of food energy transferred and lost at each step next to the appropriate arrows.

ENERGY FLOW

Heat Energy Loss



____ % Energy lost at each step.

____ % Energy passed on to next step.

1000 producers support _____ tertiary consumers.

A Food Web

Draw your food web here.

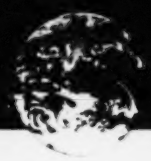
Analysis

Respond to the first seven questions as they relate to your food web.

1. Would a white-throated swift ever come to your bird feeder? Why or why not?
2. Because swifts are insect eaters, where would you commonly see them? Why?
3. What time of day would most swifts feed? Why?
4. In an urban setting, what would you have to do to attract more flying insects and, therefore, more swifts?
5. From what level of the food chain are the birds that would be seen at bird feeders?
6. How would Earth look if there were no decomposers?
7. Name two ways people might disrupt the food web you have drawn. Explain which parts of the web would be affected and how.
8. The size of each level of the energy pyramid represents the number of organisms that can survive with the energy available.
   a. Which level of the food chain has the largest number of organisms? Why?
   b. Which level of the food chain has the smallest number of organisms? Why?
9. Which level of the food chain would you conclude has the most food available to it? Explain.
10. Many scientists and other citizens think that people should eat more food that is lower on the food chain. That is, we should eat less meat and more food from plants. What is the basis for this idea as it relates to:
    a. The number of people that could be fed on plant sources versus animal sources?
    b. The amount of energy it takes to produce food from plants versus food from animals?

Part of a food chain. A female mountain bluebird carries an insect larva to its nest.

J. KENT MCDONNELL



Why Do Songbirds Need Sunlight and Plants?

What happens to a plant if it does not get sunlight? How do animals get energy from plants? How else are animals dependent upon plants? Students will learn about photosynthesis, respiration, and the carbon cycle in this investigation of the first step in the food chain.

Results of Starch Test
Iodine turns blue-black if starch is present.

Teaching Notes

Time required: This activity will take one or two class periods.

Grouping: Students may work in groups or alone.

Modifications: Use Lugol's solution instead of iodine if it is available. You may prefer to conduct the starch test for the students.

Reading supplement: Give students a reading on photosynthesis, respiration, and the carbon cycle from any biology text.

Preliminary Discussion

Discuss students' observations of birds eating and research on food sources from Project Part 1. Note that birds eat foods that are high in food energy, such as seeds, berries, insects, worms, and other animals. Discuss plant sources of food (seeds, fruits, buds, and nectar).

Technological Connections

1. View plant cells under a Demoscope, which projects the image onto a television screen.

2. Examine laser disc or CD-ROM still photographs of videotaped footage of plant cells.

Selected Answers to "Why Do Birds Need Plants?"

Photosynthesis: $6CO_2 + \text{Sunlight} + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

carbon dioxide + sunlight + water ⟶ simple sugars (glucose) + oxygen

Respiration: $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$

simple sugars + oxygen ⟶ carbon dioxide + water + energy

(Students need not balance the equations.)

"Biowups": chloroplasts, plant cell; animal body cell, mitochondria

Decomposers: $C_6H_{12}O_6 \longrightarrow CO_2$

simple sugars ⟶ carbon dioxide (*This is not a complete equation.*)

S

Extensions

1. To show that plants need sunlight to make food, apply a paper shield to a geranium leaf, leaving a cutout design in the center. Put the plant in sunlight for two or three days, then, as a demonstration, extract chlorophyll and test for starch. The procedure is in biology source books. Consult your science supervisor.

2. Cover a leaf on a plant and wait two weeks. Check the leaf for visible changes in its appearance.

3. Examine and identify the different types of cells in leaves under a microscope. What are their functions? What gives them their color? What is the reason for their different shapes?

4. Explore the process of photosynthesis further.

5. Investigate why leaves changes colors in the fall.

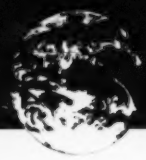
6. Discuss how the Earth's carbon dioxide balance has been affected by the burning of fossil fuels.

7. Discuss the nitrogen cycle and other cycles.

8. Discuss the fact that birds can travel to find food, and in this way are able to use food sources in different locations at different times of the year. Ask students to think of ways birds contribute to the dispersal of plants. Ask how birds and plants benefit from this dispersal.

Safety Note for Extraction of Chlorophyll:

Materials required are flammable and poisonous. Iodine solution used in the starch test is also poisonous. Use fume hood. A science corner or science room is desirable.



Why Do Songbirds Need Sunlight and Plants?

Plants are the vital link between the abundant radiant energy of the Sun and the chemical energy that most animals require for life and health. The presence and abundance of a particular species of plant can affect where birds choose to live. The timing of bud, seed, and fruit formation can also influence what time of year birds migrate.

Most plants can produce their own food using energy from sunlight to convert water (H_20) and carbon dioxide (CO_2) to simple sugars ($C_6H_{12}O_6$). Many of the simple sugars combine to form complex sugars, also known as starches. In starch, chemical food energy is efficiently stored for plants to use to function and survive. Animals eat plants to get energy in the form of **carbohydrates** (starches and simple sugars).

Task

In this experiment, you will test the fruit of a plant for the presence of carbohydrates to investigate how plants store the food they create during the process of **photosynthesis**. (Leaves can also be tested, but the chlorophyll must first be removed. This requires special materials and safety precautions.)

You will then complete a diagram that shows the cycling of carbon from plant to animal to decomposer to plant. The carbon cycle shows how food energy is produced. It will help you understand how animals like songbirds benefit from photosynthesis. You will also see how **respiration**, the process in which animals and plants take in oxygen (O_2) to use food, returns carbon to the atmosphere.

A food chain. A bird eyes a caterpillar eating a leaf.

Materials

- Slices of apple
- Waxed paper or aluminum foil
- Eyedropper
- Iodine solution

Procedure

1. Place a slice of apple on the waxed paper or foil.
2. Using the eyedropper, place a few drops of iodine solution on the apple slice.
3. Observe and record the results.

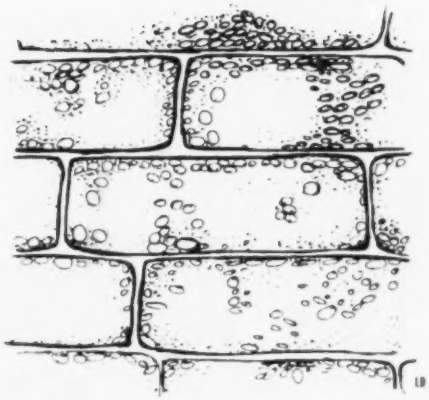
Conclusion and Analysis

1. What changes did you observe? What can you conclude from your observations?
2. Study the Activity Sheet "Why Do Birds Need Plants?" Arrows in the diagram show that plants need three ingredients to make starch. Write the names or formulas of these ingredients in the blanks.
3. Other arrows show how chemicals move between plants and animals, making them dependent upon each other. Continue to label the diagram to show how carbon dioxide, carbohydrates, and oxygen cycle through these organisms and the atmosphere.
4. Identify the plant's process of converting energy, water, and carbon dioxide to sugars and oxygen as **photosynthesis** and the animal's conversion of oxygen and sugars to energy, water, and carbon dioxide as **respiration**. Then complete the chemical equations for each process.
5. Label the types of cells where these processes take place. Photosynthesis occurs in the **chloroplasts** of plant cells, which contain chlorophyll. Photosynthesis will not occur without sunlight. Respiration takes place in the **mitochondria** of an animal's body cells. Enzymes are necessary for respiration.

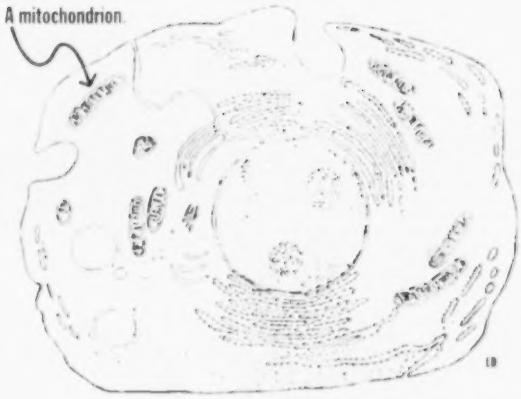
Safety Note

Iodine solution is poisonous and stains are difficult to remove. Wash hands after use.

6. Decomposers also consume carbohydrates and release carbon dioxide by eating both plants and animals after they have died. Add this information to your diagram.
7. Title your diagram: "The Carbon Cycle." You have now demonstrated how the essential element of carbon moves through living organisms and the atmosphere. The processes of photosynthesis and respiration help maintain a constant level of carbon dioxide in the atmosphere.
8. Based on what you have learned about food webs and the carbon cycle, explain how songbirds are dependent upon (a) the Sun and (b) plants.

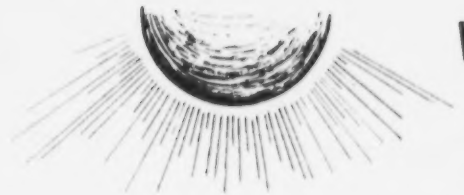


Group of plant cells. Photosynthesis occurs in the numerous spherical chloroplasts lining the walls of plant cells.



An animal cell. Respiration in animal cells is controlled by oblong mitochondria in the cytoplasm surrounding the large cell nucleus.

Why Do Birds Need Plants? ____ _____ _____



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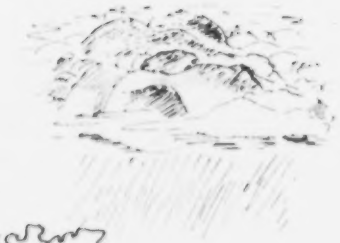

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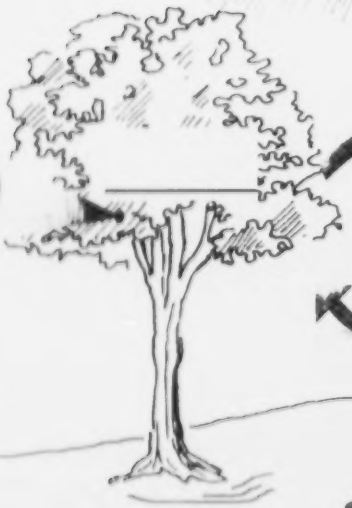

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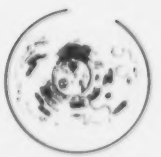


_____

Consumers

Producers

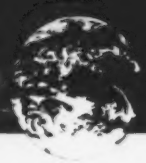
Decomposers

_____ → _____

Process of _____

Process of _____

_____ _____ _____ + _____ enzymes → chlorophyll _____ + _____ _____ + _____ enzymes → _____ + _____ + _____



Signals for the Race North

Investigation of food webs continues with an example of how bird behavior is influenced by the presence of other life forms (here, aquatic invertebrates) and, indirectly, by factors like water quality. The need for abundant food explains why birds go to the trouble of migrating.

Students examine water from a local pond or stream to determine which aquatic invertebrates live there and what the larvae grow to look like as adults. They will use these as biological indicators to assess water quality.

Stonefly Nymph (2X)

Riffle Beetle (4X)

These invertebrates are sensitive to pollution and are found only in good-quality water.

Teaching Notes

Time required: This activity needs two class periods.

Modifications: If you cannot visit a pond or stream near school property, collect water samples and bring them to the classroom for students to sort and identify.

Invertebrate identification keys: There are many keys available. If possible, have several for students to use. Students will also need insect field guides to identify the adult stage of the aquatic larvae.

Technological Connections

The following computer software provides exercises in classification: *What's the Difference? The Classification Key Tool Kit for Invertebrates* (Tom Snyder Productions, 1991).

Extensions

1. Have the students research what the sampled organisms eat.

2. Compare the biodiversity of two or more streams, ponds, or locations on the same stream.

3. Do chemical and physical tests (dissolved oxygen, pH, phosphates, nitrates, temperature, clarity) of the pond or stream water to understand water quality better.

4. Visit the water source at different times of day in the spring to identify the birds that visit or live near it.

5. Discuss the role of bud, seed, and fruit formation in influencing the timing of bird migration.

Resources

Field guides to aquatic invertebrates and insects.

Signals for the Race North

As spring draws near, migratory birds watch for signals that it is time to head north. Warmer days and longer hours of sunlight mean a burst of plant growth that attracts the primary-consumer migrants. Insect-eating migrants are more interested in what is happening in the freshwater ponds, streams, and wetlands. Here they find a population explosion of invertebrate organisms such as mosquitoes, flies, and gnats. Most of these lay their eggs in or around fresh water and live as larvae in the ponds, streams, or moist ground surrounding them. As the larvae change into airborne adults, the migratory songbirds arrive to feast on an all-you-can-eat smorgasbord!

An additional reward is that longer days give them more time to gather food for their young, so the new generation of songbirds has a better chance of surviving.

Yellow warbler, shown in its nest, eats insects.

AUDUBON NATURALIST SOCIETY

Task

You will identify the characteristics of a local pond or stream that influence aquatic life. You will collect and identify invertebrate organisms to determine the biodiversity of the water body and evaluate water quality.

Materials

For on-site collection:

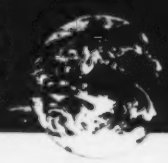
- Plastic buckets
- Plankton net or mesh net with plastic cup or bowl
- Shovel, strainer, or other scoop
- Shallow dish (gold pan, pie pan)

For classroom or on-site sorting and identification:

- Jars, muffin tins, plastic egg cartons, paint palettes
- Soft paint brushes
- Tweezers
- Bug box or field microscope
- Magnifying lens
- Binocular scope
- Aquatic invertebrate identification keys and Information Sheet
- Field guides to insects

FIELD SCIENCE GOLDEN RULE

No field study should harm an animal or habitat in any way. Replace all organisms, rocks, and plants where you found them.



A Freshwater Setting

Draw a map of the pond or stream. Orient the map and draw on it an arrow pointing north. Identify and put on the map characteristics that can influence aquatic life: deep pools, shade plants, overhanging banks, riffles, algae, and large rocks and other places for animals to hide. Describe the size, depth, canopy cover (overhanging vegetation such as tree branches), and bottom of the pond or stream. Describe the materials (rocks, sand, gravel) at the bottom of the pond or stream. Mark the direction of water flow, if any. Describe each of the characteristics labeled on your map. Also note any signs of people's effects on the area.

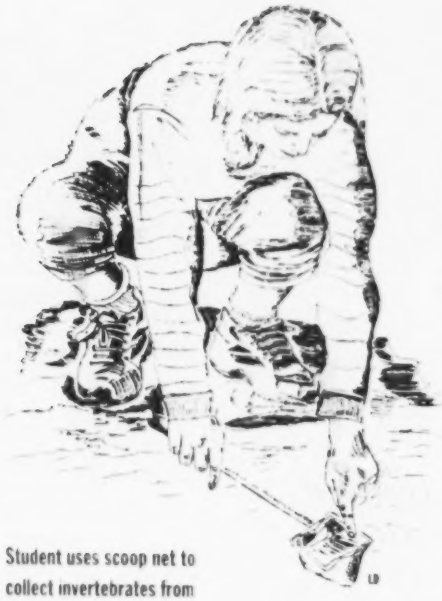
Safety Note:
Possible risks, such as poisonous plants or animals and polluted or hazardous water, may be present in your water source. Necessary precautions may include learning the characteristics of poisonous species before beginning research, wearing waders or plastic gloves, and conducting your research in carefully chosen sections of the water source.

In Search of Aquatic Life

Use the following methods to find invertebrate organisms in your pond or stream.

1. Find large rocks, logs, algae, and plants from the pond or stream bottom and examine them for small invertebrate organisms.
2. Use shovels, strainers, or other scoops to empty small amounts of plant matter and bottom material along with some water into a container.
3. Use a plankton net or any mesh net with a built-in plastic cup or bowl to collect specimens from the bottom layer of water.
4. Use shallow pans to collect surface-dwelling organisms.
5. Carefully remove the organisms with tweezers, your fingers, a brush, or other available tools and separate them into jars, muffin tins, or egg cartons filled with pond or stream water. Identify the organisms using the "Aquatic Invertebrate Identification Key" provided and count the number of specimens.

Make a data chart, using a large sheet of paper, for recording your findings. Include your name, the sampling date, and location. Add these columns: Collection Technique, Type of Organism, Number Present, Physical Description and Drawing, Behavior Description (Movement), and Drawing of an Adult.



Student uses scoop net to collect invertebrates from rocks in a stream.

Evaluating Water Quality

Certain animals are more sensitive to pollution than others. Because water quality affects which organisms can survive in a body of water, the types of organisms present in the pond or stream indicate the quality of the water. The number of organisms is also significant.

In good conditions, there should be a diverse and abundant community of macroinvertebrates, which can be seen without a microscope, including those sensitive to pollution. If any factor upsets the ecological balance, there will be fewer types of organisms. There will also be fewer organisms of some types, but more of other types, such as "grazers," which eat algae and vegetation.

To measure accurately the biodiversity of a stream or pond, you should collect data over a period of time. Data from different times are important because counts are affected by the season, recent rainstorms, and natural fluctuations in the populations of the organisms.

A biotic index is one way of using the biodiversity of the water body to evaluate water quality. The types of macroinvertebrates present are counted and sometimes the number of individual organisms of each type. A formula is then used to compute a value that rates the quality of the stream or pond water. (See Izaak Walton League, Resources)

Analysis

1. How might the size, depth, canopy cover, and bottom of your body of water affect the number and diversity of organisms that live there?
2. How many different types of organisms did you find?
3. Which types of organisms were the most abundant?
4. Which of the three categories had the most species?
5. What did your collection of organisms tell you about the water quality?
6. What human effects are present around your pond or stream that might affect the water quality?
7. What effect could water quality have on the survival rate of aquatic invertebrates? On the number of adult aquatic invertebrates?
8. What indirect effect could water quality have on songbird populations?
9. Which migratory songbird populations in your community would feed on the adults of the aquatic invertebrates you identified?

Aquatic Invertebrate Identification Key

SENSITIVE:
Organisms sensitive to pollution, found in good-quality water.

Caddis Fly Larvae. Up to 1 inch long; 6 hooked legs on upper third of body, 2 hooks at back end. May be in a case made of sticks, small rocks, or leaves with its head sticking out. May have fluffy gill tufts on lower tail.

Mayfly Nymphs. 1/4 to 1 inch long; 6 large hooked legs; antennae; 2 or 3 long, hair-like tails that may be webbed together; brown, moving, plate-like, or feathery gills on sides of lower body.

Gilled Snails. Shell opening covered by thin plate called operculum. Shell usually opens on right.

Caddis Fly Larvae

Mayfly Nymph

Gilled snails

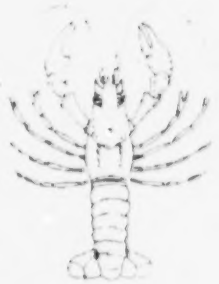
SOMEWHAT SENSITIVE:
Organisms somewhat tolerant of pollution, found in good- or fair-quality water.

Crayfish. Up to 6 inches long, 2 large claws, 8 legs. Resembles small lobster.

Damselfly Nymph. 1/2 to 1 inch long; 6 thin hooked legs; 3 broad oar-shaped tails positioned like a tripod. Smooth (no gills) on sides of lower half of body.

Crane Fly Larvae. 1/3 to 2 inches long; 4 finger-like lobes at back end; milky, green, or light brown, plump caterpillar-like segmented body.

Dragonfly Nymph. 1/2 to 2 inches long; 6 hooked legs; large eyes; wide, oval to round abdomen.


Crayfish

Damselfly Nymph

Crane Fly Larva

Dragonfly Nymph

TOLERANT:
Organisms tolerant to pollution, found in any quality water.

Aquatic Worms. 1/4 to 2 inches long, can be tiny; thin, worm-like body.

Midge Larvae. Up to 1/4 inch long; dark head, worm-like segmented body, 2 tiny legs on each side.

Blackfly Larvae. Up to 1/4 inch long; one end of body wider; black head; suction pad on one end.

Pouch and Pond Snails. No operculum covering shell opening; snails breathe air. Shell usually opens on left.

Aquatic Worms

Midge Larva

Blackfly Larva

Pouch and Pond Snails

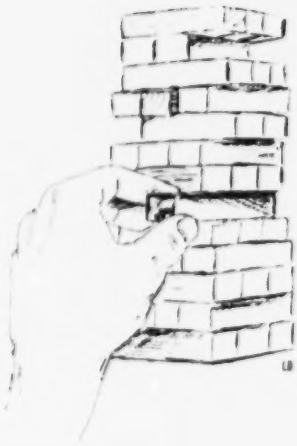
The invertebrates in this key are common types. You may find others that you will need a field guide to identify.

Adapted from "Stream Insects & Crustaceans." Save Our Streams Program, Izaak Walton League of America.

Activity 2: *Jenga* Tower

Set up the game *Jenga* in a prominent location in the room. (The game can be purchased at most toy stores. Ask your students!) For atmosphere, dim the lights and focus one light on the tower of blocks. Have the students gather around the tower. Tell students that this tower represents Earth or a particular ecosystem. Ask what each of the blocks represents. (A plant or animal species on Earth.) The challenge for the class is to keep Earth's natural system from collapsing. Each student should think of an animal or plant that is endangered or extinct. Then, when you call on students one at a time to go to the tower, they should tell the class the name of the species and why that species is endangered or extinct (if known) and remove one block from the middle of the tower to represent the species' disappearance from Earth (ecosystem). Once it is removed, each block should be set on the table around the base of the tower as a reminder of a species lost.

Next, ask students to explain the collapse of the tower as it relates to Earth's natural stability.



Jenga Tower.

Extensions

1. Discuss or research the political and economic consequences of regulations and other means of attempting to protect species of birds and other animals.
2. Read about or research specific endangered species.
3. Study the Endangered Species Act. Evaluate its effectiveness and the controversy over it. Discuss support for and resistance to creating an Endangered Ecosystems Act.
4. Write your member of Congress about your concerns on biodiversity, a particular endangered species, threats to migratory birds, or the Endangered Species Act.

Resources

Ehrlich, Paul, and Ehrlich, Anne. (1981). *Extinction: The Causes and Consequences of the Disappearance of Species.* New York: Random House.

Jenga. Milton Bradley Co.

Moseley, Charles, J., (Ed.). (1992). *The Official World Wildlife Fund Guide to Endangered Species of North America, Volume 3.* Washington, D.C.: Beacham Publishing, Inc.

The *Jenga* activity was developed with Cindy Guy and Sheila Lamb.

Why Care About the Golden-cheeked Warbler?

This activity uses two analogies to teach students why biodiversity is necessary to the stability of ecosystems. The key questions are (1) Should we try to save every species on Earth? and (2) What happens to an ecosystem when species become extinct?

You may choose to divide the class into two groups and have each participate in only one of the activities.

Activity 1: "The Rivet Poppers"

Read students the first column of the "The Rivet Poppers" (the preface to *Extinction: The Causes and Consequences of the Disappearance of Species,* by Paul and Anne Ehrlich). The length of the excerpt should be selected to suit the age and ability of the class.

Before you begin reading, distribute photocopies of the Activity Sheet. Tell students that as they listen, they should think about what the following parts of the story might represent in the study of ecosystems, food webs, and the disappearance of songbirds: rivet, rivet popper, plane, passengers on the plane, the plane's ability to fly.

Read "The Rivet Poppers." Then ask what the following parts of the story represent.

1. A rivet. (Any species on Earth.)
2. A rivet popper. (Any person—or group of people—who in some way threatens the survival of a species. See the second section of the story for details.)
3. The plane. (Earth or an ecosystem.)
4. Passengers on the plane. (People and all species that are a part of Earth or ecosystem.)
5. The plane's ability to fly. (The ability of Earth or an ecosystem to survive, which is dependent on the continued existence of various species—that is, on how many rivets are needed to stabilize the wing.)

Ask students what the main message of the analogy is. (No one knows how many rivets can be removed before the wing will fall off, causing the plane to crash. Similarly, no one knows how many—or which—species can be taken from Earth or an ecosystem before the natural system will collapse.)

The Rivet Poppers (Excerpt)

Paul Ehrlich and Anne Ehrlich

As you walk from the terminal toward your airline, you notice a man on a ladder, busily prying rivets out of its wing. Somewhat concerned, you saunter over to the rivet popper and ask him just what ... he's doing.

"I work for the airline—Growthmania Intercontinental," the man informs you, "and the airline has discovered that it can sell these rivets for two dollars apiece."

"But how do you know you won't fatally weaken the wing doing that?" you inquire.

"Don't worry," he assures you. "I'm certain the manufacturer made this plane much stronger than it needs to be, so no harm's done. Besides, I've taken lots of rivets from this wing and it hasn't fallen off yet. Growthmania Airlines needs the money; if we didn't pop the rivets, Growthmania wouldn't be able to continue expanding. And I need the commission they pay me—fifty cents a rivet!"

"You must be out of your mind!"

"I told you not to worry; I know what I'm doing. As a matter of fact, I'm going to fly on this flight also, so you can see there's absolutely nothing to be concerned about."

Any sane person would, of course, go back into the terminal, report the gibbering idiot and Growthmania Airlines to the FAA, and make reservations on another carrier. You never *have* to fly on an airliner. But unfortunately all of us are passengers on a very large spacecraft—one on which we have no option but to fly. And, frighteningly, it is swarming with rivet poppers behaving in ways analogous to that just described...

Rivet-popping on Spaceship Earth consists of aiding and abetting the extermination of species and populations of nonhuman organisms. The European Lion, the Passenger Pigeon, the Carolina Parakeet, and the Sthenele Brown Butterfly are some of the numerous rivets that are now irretrievably gone; the Chimpanzee, Mountain Gorilla, Siberian Tiger, Right Whale, and California Condor are prominent among the many rivets that are already loosened. The rest of the perhaps ten million species and billions of distinct populations will more or less hold firm. Some of these species supply or could supply important direct benefits to humanity, and all of them are involved in providing free public services without which society could not persist.

The natural ecological systems of Earth, which supply these vital services, are analogous to the parts of an airplane that make it a suitable vehicle for human beings. But ecosystems are much more complex than wings or engines. Ecosystems, like well-made airplanes, tend to have redundant subsystems and other "design" features that permit them to continue functioning after absorbing a certain amount of abuse. A dozen rivets, or a dozen species, might never be missed. On the other hand, a thirteenth rivet popped from a wing flap, or the extinction of a key species involved in the cycling of nitrogen, could lead to a serious accident.

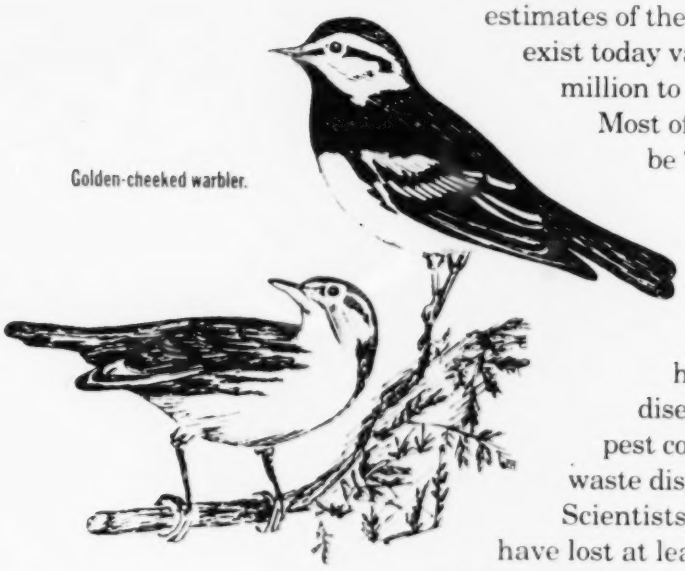
In most cases, an ecologist can no more predict the consequences of the extinction of a given species than an airline passenger can assess the loss of a single rivet. But both can easily foresee the long-term results of continually forcing species to extinction or of removing rivet after rivet. No sensible airline passenger today would accept a continuous loss of rivets from jet transports. Before much more time has passed, attitudes must be changed so that no sane passenger on Spaceship Earth will accept a continuous loss of populations or species of nonhuman organisms.

Over most of the several billion years during which life has flourished on this planet, its ecological systems have been under what would be described by the airline industry as "progressive maintenance." Rivets have dropped out or gradually worn out, but they were continuously being replaced; in fact, over much of the time our spacecraft was being strengthened by the insertion of more rivets than were being lost. Only since about ten thousand years ago has there been any sign that the process might be more or less permanently reversed. That was when a single species, *Homo sapiens*, began its meteoric rise to planetary dominance. And only in about the last half-century has it become clear that humanity has been forcing species and populations to extinction at a rate greatly exceeding that of natural attrition and far beyond the rate at which natural processes can replace them. In the last twenty-five years or so, the disparity between the rate of loss and the rate of replacement has become alarming; in the next twenty-five years, unless something is done, it promises to become catastrophic for humanity....

From *Extinction: The Causes and Consequences of the Disappearance of Species*, by Paul Ehrlich and Anne Ehrlich, 1981, New York: Random House. Copyright 1981. Excerpted by permission.

Why Care About the Golden-cheeked Warbler?

The variety of life on Earth, **biodiversity**, is a unique and stabilizing feature of our planet. Scientific estimates of the number of species that exist today vary from as few as 5 million to as many as 30 million. Most of these species have yet to be "discovered," classified, and studied by our global scientific community. Some of these plant and animal species may hold the key to cures for diseases, new food sources, pest control, sanitation and waste disposal, and more. Scientists predict that we will have lost at least one million species by the year 2000!

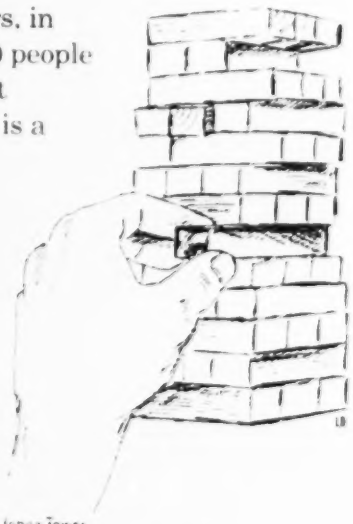


Golden-cheeked warbler.

This loss would be greater than any mass extinction, including that of the dinosaurs, in geological history. Why (or even whether) people should care about seemingly insignificant species, like the golden-cheeked warbler, is a topic of hot debate in communities throughout the world.

Task

You will participate in one or both class activities on biodiversity. As you discuss and analyze these analogies, you will begin to understand why biodiversity is necessary for ecosystem stability.



Jenga Tower.
What does each block represent?

Questions

1. Define:

Bio= _____ and Diversity =_____

Biodiversity _____

_____

2. In the analogy based on "The Rivet Poppers," what do the following represent?
   a. A rivet
   b. A rivet popper
   c. The plane
   d. Passengers on the plane
   e. The plane's ability to fly
3. What is the main message of the "Rivet" analogy?
4. In the analogy based on the *Jenga* tower, what do the following represent?
   a. The tower
   b. A wooden block
   c. Removal of a block from the tower
5. What is the main message of the *Jenga* analogy?

Analysis

1. List human actions that threaten species' survival across the world. Then list your own actions that may contribute to any species' decline.
2. "No one knows when the plane/tower/ecosystem will fall. It could be from the loss of a well-known species like the mountain gorilla, a little-known species like the golden-cheeked warbler, or a species that most of the world does not know exists." What conclusions can you draw from this statement?
3. Explain how these two activities illustrate the importance of an ecosystem's biodiversity.
4. Choose one of the two activities to use as an analogy to explain the concerns about songbirds. In your explanation include:
   a. Examples of threats to songbirds
   b. Threats to the diversity of their ecosystem
   c. Reasons why songbird species should be protected from future extinction
5. Interpret this quotation: "The first rule of intelligent tinkering is to save all the parts." — Aldo Leopold.

Seiko Finalists Focus on Golden-cheeked Warbler

Each year since 1990, Seiko Corporation of America has challenged high school students to work on environmental problems specific to their community. The science team at Westwood High School in Austin, Texas, was named a Seiko Regional Finalist in 1994 for its work to save the golden-cheeked warbler.

The warbler was placed on the federal list of endangered species in 1990. Its nesting range, in central Texas, is threatened by urban development and a policy of eradicating juniper trees to clear land for pasture. The warbler makes its nests from the bark of Ashe juniper and requires a mixed woods of mature Ashe juniper and oaks for nesting.

Student Lisa Rochelle described the work that made the team a winner. "By gathering information about all facets of the conflict concerning the preservation of the golden-cheeked warbler in our community, we hoped to bring people on all sides of the issue to a common viewpoint, from which they could strive towards a single goal.... What we discovered is that people on all sides of the issue value life, so they share a common desire, the preservation of life. The challenge is in bringing the life of the virtually unseen and unheard golden-cheeked warbler to their attention and making it real to them."

Seiko Youth Challenge 1994
Regional Finalist Science Team
Stacy Love, Lisa Rochelle, and Katie Schmid
Westwood High School,
Austin, Texas.
Faculty advisor: Joy Killough

Golden-cheeked warbler.

And the Web Came Tumbling Down

By now, students have an understanding of the interdependence of species and are ready to examine how human actions change the natural balances of an ecosystem.

The examples in this activity help answer the key questions: (1) Why are songbirds disappearing? and (2) How can we help protect songbirds from the many threats to their survival caused by human activities?

Teaching Notes

Time Required: This activity takes one class period.

Grouping: The activity can be completed in several ways.

1.) Students may work individually on all "disruptions."

2.) Students may work on all disruptions in cooperative groups of two to four. They can rotate responsibilities of *reader*, *recorder* and *problem solvers* for each disruption. The problem solvers give their responses to the questions first.

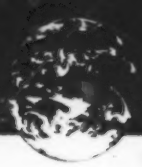
3.) Students may work in six cooperative groups, with each group studying one disruption. The group interprets the problem and records their responses on butcher or construction paper. They then present the information to the class and display the poster. They can divide responsibilities as follows: The *disruption specialist* chooses a title and writes a brief factual description of the problem. The *illustrator* draws a picture that represents the disruption. The *recorder* writes down the responses to questions. The *reader* holds the text and designs the poster by deciding how to arrange the information.

Technological Connections

Use videotape, laser discs, or CD-ROMs to illustrate some of the disruptions.

Extensions

1. Research one or more of the disruptions.
2. Determine through interviews with birding organizations, state or national park agencies, or state wildlife scientists what the greatest threats are to birds in your community or state.
3. Investigate community attitudes toward free-roaming domesticated and feral cats.



And the Web Came Tumbling Down

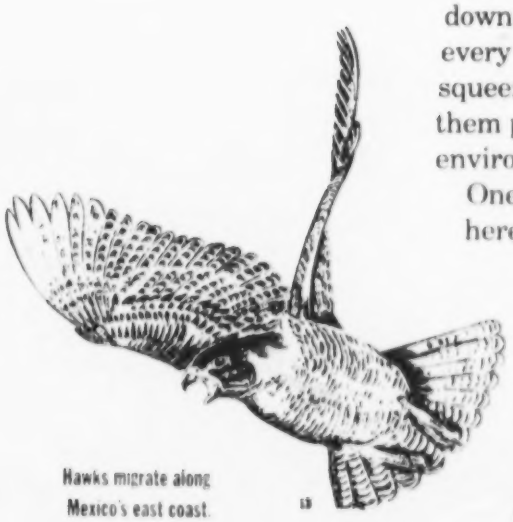
You have constructed a food web for a neotropical migrant and investigated how these birds depend on sunlight, plants, and other animals. A stable web of life seems simple to maintain—until the species *Homo sapiens* (humans) is added to the picture. Many human desires and needs threaten the balance of food webs. In this activity, you will analyze the effects of a variety of human actions on the food webs of migratory birds.

Task

Read about each food-web disruption. Then answer the questions to determine how the disruption is caused by human actions and identify possible solutions to these problems.

Disruption 1: Loss of Habitat

"Mexican biologists have documented what is probably the greatest raptor migration in the world—the passage of more than 2.5 million hawks, falcons, kites, vultures, and several nonraptor bird species down Mexico's east coast through Veracruz every autumn. The fact that so many hawks squeeze through such a small area makes them particularly susceptible to environmental changes there."



Hawks migrate along Mexico's east coast.

One biologist explains, "Most of the land here in central Veracruz has been converted to grassland or sugarcane, and you can see how scarce and patchy the remaining trees are. This forces the hawks into marginal roost sites like steep canyons, even banana and mango plantations, and makes them much more vulnerable to predation, to humans, and to fires, which are common in the spring." (Quotations from "Secrets of the Hawks," by Scott Weidensaul, *International Wildlife*, November/December, 1994, pp. 46–49.)

Questions

1. Migratory raptors (hawks, eagles, falcons) and migratory songbirds face similar threats throughout the world. Why are these birds so vulnerable to environmental changes in and around Veracruz?
2. How are people's actions reducing the area's ability to serve as a migration stop for birds?
3. How are the birds responding to these changes?
4. Raptors are extremely effective predators of rodents, insects, and songbirds. How would their population reduction affect their prey populations?

Disruption 2: Pesticides

Migratory birds face different pesticide threats in each country they pass through. The United States has banned use of some pesticides within its borders because of extreme wildlife hazards. But some banned pesticides are still being manufactured, and U.S. companies continue to sell them to developing countries.

One such pesticide, DDT, threatens migratory songbirds, migratory raptors, and all other animals in their food webs. Studies have shown that predatory birds such as falcons, eagles, and pelicans accumulate DDT in their bodies after eating DDT- contaminated prey. The pesticide weakens the shells of the birds' eggs so much that the eggs may break when a parent tries to incubate them. "Sprayed on crops [in Mexico], the persistent chemicals [DDT] are eaten by insects, which in turn are eaten by other animals, including songbirds, so that toxins work their way up the food chain to raptors." (Quotations from "Secrets of the Hawks," by Scott Weidensaul, *International Wildlife*, November/December, 1994, pp. 46–49.)

Use of the pesticide carbofuran on agricultural fields in Virginia left tens of thousands of birds dead. The Environmental Protection Agency banned it in the United States in 1991.

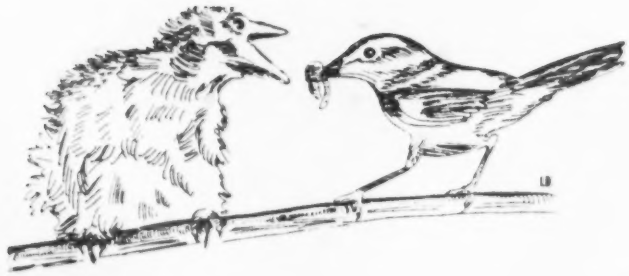
Pesticides poison birds.

Questions

1. Explain how most migratory songbirds would fit into this poisoned web.
2. What changes in U.S. government and company policies would be necessary to protect migratory birds' complex food webs from the impact of hazardous pesticides? Do you propose such a change in policy? If so, defend your proposal.
3. Draw a food web that shows where carbofuran is sprayed and how it moves up the food chain, through songbirds, to the top consumers.

Disruption 3: Parasitic Cowbirds

Many scientists believe the cowbird is a major threat to many of North America's songbirds, particularly the neotropical migrants that winter in Central America and South America or on Caribbean islands. The brown-headed cowbird does not build nests. Instead, it uses the nests of other songbirds. The female cowbird destroys some of the eggs in another bird's nest and replaces them with her own. She then leaves to repeat this action in other nests. The host bird unknowingly hatches and raises the cowbird's young. The cowbird's chicks are much larger than the host's young, so they win any sibling battles for food and parental attention.



Cowbirds are parasites. They lay eggs in other birds' nests and let that bird raise their cowbird young.

Biologist Scott Robinson studied the effects of cowbirds in Illinois. "Over the past five breeding seasons, his research team has monitored more than 2,000 nests of 18 species, [determining how cowbirds] affect nesting success and population trends. The picture is not encouraging. Cowbirds parasitize 9 out of 10 wood thrush nests and 8 out of 10 nests of arboreal birds like the scarlet tanager, yellow-throated warbler, and red-eyed vireo. Sixty percent of all nests contain cowbird eggs or young." (Quotation from "Curse of the Cowbird," by Les Line, *National Wildlife*, December/January, 1994, pp. 40–45.)

Questions

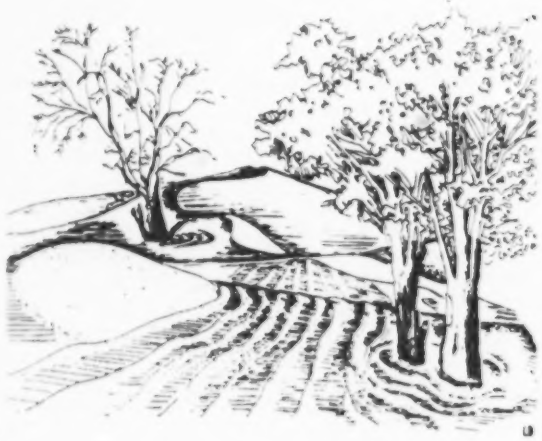
1. How does parasitic behavior like that of cowbirds fit into a food web?
2. Why do cowbirds behave this way? How does it help their population?
3. Cowbirds often lay eggs in nests that are along the edges of forests. Many large forests have been broken into fragments as a result of human population growth and related development. Explain what connection you would expect between development and the stability of songbird populations in areas where cowbirds live.
4. What interventions would you propose to control the cowbird's damage to songbird populations? What additional information might you need to determine which intervention would be most successful and acceptable to the general public and to the scientific world?

Disruption 4: Desertification

White-throated warblers breed in Britain and migrate to Africa in the winter. The bird's populations have dropped 75 percent in 27 years, due to desertification in its wintering grounds.

Questions

1. What is desertification?
2. What are some possible human causes of desertification in Africa?



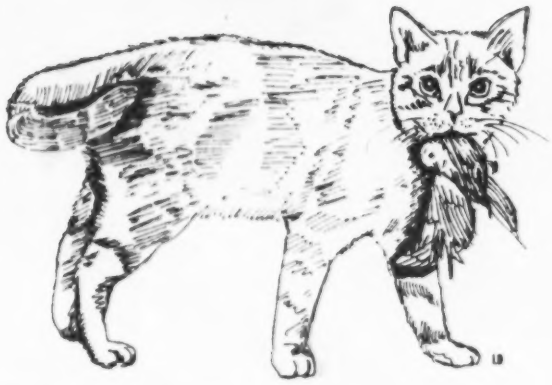
Human activity and climate change create desert areas where forest used to be.

Disruption 5: Dining on Songbirds

In Italy, diners feast on 50 million songbirds each year. Other songbirds are eaten as delicacies by people worldwide.

Questions

1. Where in songbirds' food webs do these humans fit?
2. How might this human-caused disruption of songbirds' natural food webs affect songbird predators? Songbird prey and food sources?
3. What national policies related to this disruption can you propose to help stabilize the songbird food webs?



Cats kill millions of birds each year.

Disruption 6: Cats

Domestic and feral (previously domesticated) cats have been held responsible for killing hundreds of millions of songbirds. In Wisconsin alone, scientists estimate that rural cats kill 20 to 150 million songbirds each year. This represents 35 percent of a cat's diet! Research has shown that cats can hunt silently, even with a bell collar on. Declawed cats are still able to catch birds effectively.

Questions

1. Draw a simple songbird food web that includes cats.
   a. Songbirds are not the cats' total diet. Add to the web other wild animals and food sources that cats feed on.
   b. What do the cats' prey eat? Add these items.
   c. Include predators that eat cats.
2. Almost all animals have predators. How can domestic and feral cats disrupt the natural balance of the songbirds' food webs?
3. What can cat owners do to keep their pets from harming birds and other wildlife?

References

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Project Part 2: A Neighborhood Made for Migratory Songbirds

Students will now use their knowledge to create a habitat that lures birds to their neighborhood. Besides finding out what they can learn from watching songbirds and other wildlife, students will learn how they can help local migratory birds throughout the year.

Teaching Notes

Time Required: This part of the project requires advance planning. Introducing the subject and setting up the habitat takes two class periods. After the feeders are up, they should be kept up for at least two weeks. Birds may take days or weeks to find the new food source. While waiting, students can spend their class and independent time researching and preparing the other parts of the project. After the observation period, there will be seven class periods of activities, including the presentations.

Suggested Schedule:

Days 1 and 2: Complete Steps 1, 2, 3A, and 3B (log, setting up habitat, map of habitat, habitat history).

Interim Period: Record individual observations in wildlife logs for two to four weeks and conduct related, teacher-selected activities during class time.

Days 3 and 4: After a minimum of two weeks of observations, begin the summary with Step 3C (species identification and field guide).

Days 5, 6, and 7: Complete Steps 3D, 3E, and 3F (food web, bird behaviors, suggestions for improvements).

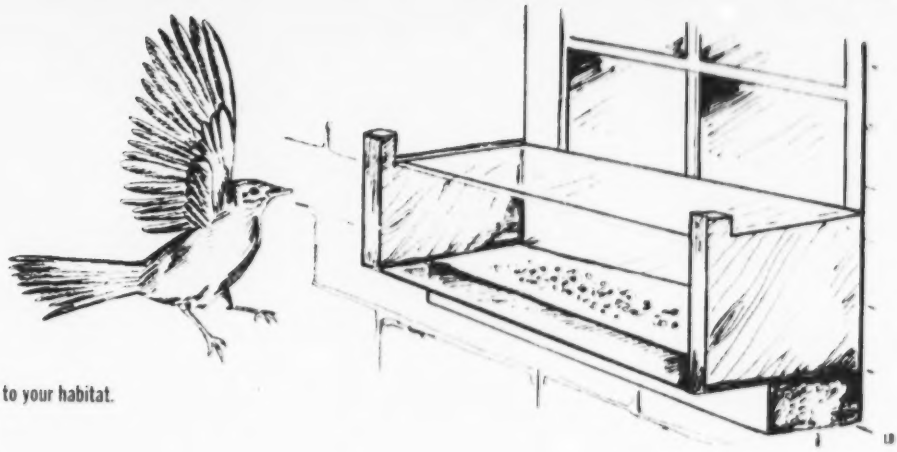
Days 8 and 9: Complete Step 4 (student presentations).

Precautions
Ask a local wildlife agency or birding organization for advice to ensure that you don't assist birds that are considered pests.

Information Supplements

1. Show Roger Tory Peterson's video "Attracting Birds To Your Backyard" as an introduction to the project.

2. Contact your local Audubon Society chapter, birding organizations, feed stores, state wildlife agency, or a nature center for lists of suggested bird food preferences for local species. (See food preferences, p. 44).



Food will attract birds to your habitat.

3. Obtain bird identification posters from Project FeederWatch, the state wildlife agency, or local sources. Hang these around the room for students to refer to throughout the study period.

4. Have younger students make feeders and put them outside their classroom window. Set up a class observation sheet near the window to be filled out with teacher assistance when birds are seen. If the feeders are taken home, make observations a family project so that parents can help. Identification is optional.

Technological Connections

1. Cornell Lab's Project FeederWatch is working on computer network opportunities (see Resources).

2. Graphical analysis computer software can be used to graph such daily variations as the number of birds in the habitat, the number of birds at each feeder, and the number of different species in the habitat or at the different feeders.

3. Presentations could include various technologies: videotape; computer Hypercard or Hyperstudio stacks; computer draw, paint, or clip-art software; or graphics or photographs of habitats, biomes, species, or human and nonhuman threats from laser discs or CD-ROMs.

Extensions

1. See graphing options in Technological Connections.

2. The types of bird attractors (food, water, shelter, nesting materials) needed will depend on season and location.

Feeders can be set up in fall or winter, with additional attractors (nesting materials, hummingbird feeders, and plantings for wildlife) added in spring as a follow-up project.

3. Share your knowledge. Present the final studies to other classes, other schools, or birding organizations. Display the studies in the school or community center.

4. Help schools, businesses, and families create wildlife habitats.

5. Continue observations beyond the formal study. Place new wildlife attractors in the habitat in different seasons. By observing birds that visit the habitat throughout the year, students can identify seasonal migratory visitors and year-round residents and will see a greater diversity of birds and other wildlife.

6. Design and plant a wildlife garden with a variety of native foods for birds, butterflies, and mammals.

7. Visit a park, museum, or zoo to see and learn more about local or international bird species.

References and Resources

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Cosgrove, Irene. (1976). *My Recipes Are for the Birds.* Doubleday, Garden City, NY

Field guides to birds (see Resources, page 50).

Peterson, Roger Tory. (1986). *Attracting Birds to Your Backyard.* (Videotape). Nature Science Network, Inc., 108 High Street, Carrboro, NC 27510.

Wing, Lucy. (1990, December). Ornaments for the Birds. *Country Living,* 148.

Suggested Resources

(See Resources.)

- Project FeederWatch, Cornell Lab of Ornithology
- Birds in the Balance Campaign, National Audubon Society
- Backyard Wildlife Habitat Program, National Wildlife Federation
- Wild Birds Unlimited

Different Seeds and the Birds Attracted to Each

Source: Wild Birds Unlimited, Inc.

OIL SUNFLOWER
Cardinal*
Chickadee*
Mourning Dove
Goldfinch
Grackle
House Finch*
Purple Finch*
Evening Grosbeak*
Blue Jay
Slate-colored Junco
White-breasted Nuthatch*
Pine Siskin
Redpoll
Red-winged Blackbird
House Sparrow
Song Sparrow
White-crowned Sparrow*
White-throated Sparrow*
Tufted Titmouse
Woodpeckers

THISTLE (NIGER)
Brown-headed Cowbird
Goldfinch*
House Finch
Mourning Dove
Purple Finch
Slate-colored Junco
Pine Siskin*
House Sparrow
Song Sparrow
White-throated Sparrow

SUNFLOWER CHIPS
Cardinal
Chickadee
Brown-headed Cowbird
Mourning Dove
Goldfinch
Grackle
House Finch
House Sparrow
Pine Siskin*
Red-winged Blackbird
White-throated Sparrow

STRIPED SUNFLOWER
Cardinal
Chickadee
House Finch
Purple Finch
Grackle
Evening Grosbeak
Blue Jay*
White-breasted Nuthatch
House Sparrow
White-throated Sparrow
White-crowned Sparrow
Tufted Titmouse*
Red-bellied Woodpecker*

CRACKED CORN
Eastern Bluebird
Cardinal
Mourning Dove
Rock Dove
Grackle
Blue Jay
Slate-colored Junco
Red-winged Blackbird
House Sparrow
Tree Sparrow
White-throated Sparrow
Starling
Brown Thrasher
Red-bellied Woodpecker

PEANUT KERNELS
Chickadee
Blue Jay*
White-breasted Nuthatch
House Sparrow
Tufted Titmouse*
Woodpeckers

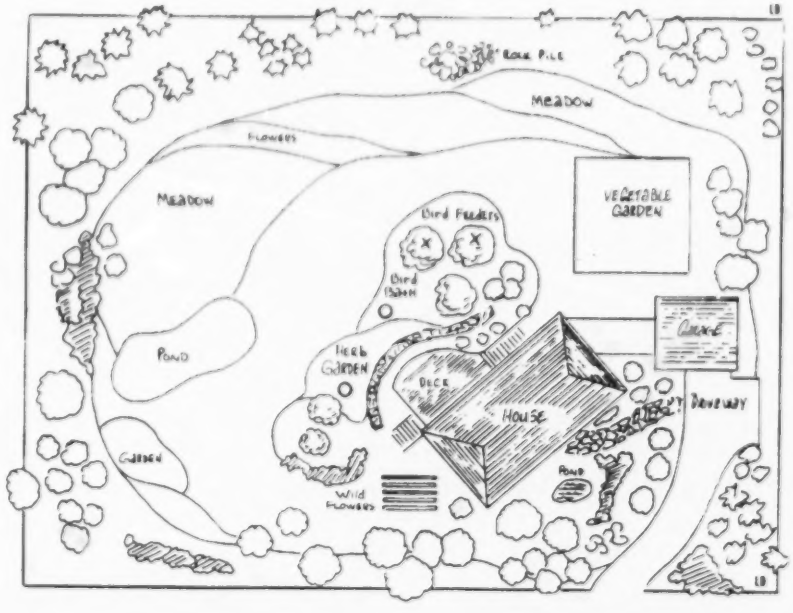
PEANUT HEARTS
Brown-headed Cowbird
Slate-colored Junco
White-throated Sparrow
Starling*

SAFFLOWER
Cardinal
Chickadee
Mourning Dove
House Finch
Blue Jay
White-breasted Nuthatch
House Sparrow
Tufted Titmouse
Red-bellied Woodpecker

WHITE MILLET
Cardinal
Brown-headed Cowbird*
Mourning Dove*
Slate-colored Junco*
Red-winged Blackbird
Pine Siskin
House Sparrow*
Song Sparrow*
Tree Sparrow*
White-crowned Sparrow
White-throated Sparrow
Starling*

RED MILLET
Same list as for white millet, but generally not as well liked.

* Favorite choice



A habitat map.

Scale:
1 cm=10 meters

Project Part 2: A Neighborhood Made for Migratory Songbirds

Habitat loss is the primary cause of the stresses to and decline of bird populations. More than 70 percent of forest in the United States has fallen to development. Bird counts coordinated by the U.S. Fish and Wildlife Service (and now by the National Biological Service) in the Breeding Bird Survey have shown a drop since 1980 in songbird population sizes across Canada and the United States. For example, the rose-breasted grosbeak population has decreased by 40 percent and the blackpoll warbler by 60 percent. As previously undisturbed woodlands and other ecosystems become fragmented or disappear, birds' needs are not met and other threats intensify. Songbirds are exposed to predators and parasitic cowbirds along the fringes of the forest.

A rose-breasted grosbeak.

Anyone can help stabilize songbird populations by creating a habitat at home, school, or work that gives birds food, water, shelter, and nesting places lacking elsewhere. These birds will become valued members of the neighborhood that you can observe and study.

Task

In your yard, on the school grounds, or at a nearby park or open space, you will create an appealing habitat for birds and other wildlife to use. Observe and identify the animals that come to the area and determine whether they are summer visitors, winter visitors, or year-round residents. Apply the concepts learned in this unit to designing your

Get Involved

- Join Project FeederWatch and add your bird observations to Cornell Lab of Ornithology, Bird Population Studies program (see Resources, page 51).
- Have your habitat nationally certified by the National Wildlife Federation Backyard Wildlife Habitat Program (see Resources, page 51).

habitat. Then observe the birds' activity for at least two weeks and learn about the role these birds play in your neighborhood ecosystem.

Materials

- Two or more types of bird seed (see Seed Preferences, p. 42)
- Two or more bird feeders*
  For a bottle feeder: 1-gallon or 2-liter plastic bottle, Exacto knife, coat hanger, wire cutters
  For a pinecone feeder: pinecone or yucca (or other) seed pod, string, peanut butter, knife
  For a garland of food to drape over branches: needle and thread, popcorn, raisins, cranberries, cheese
- Nesting materials (if the study is done in the spring)*

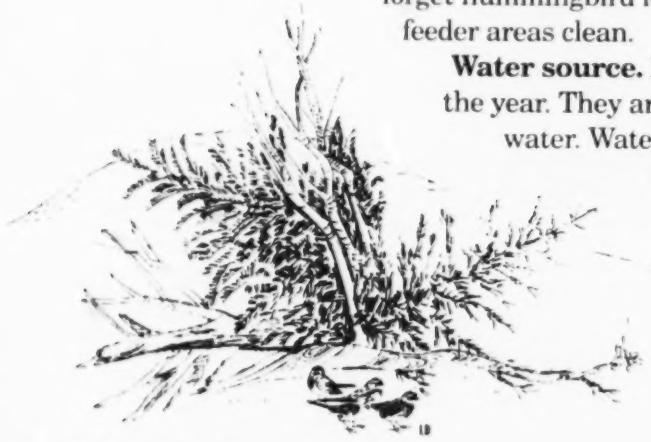
How to Create a Wildlife Habitat

The location of your yard and season of year you are beginning this project will influence how you set up the bird habitat. Use or improve on any of the wildlife attractors described below. Information on bird food preferences, construction of birdhouses and feeders, sanitation and maintenance at feeders, and nesting materials is readily available.

Bird feeders. Feeders may be put up at any time during the year, although fall and winter are the common seasons. Be sure to place them off the ground in a location safe from disturbances and attacks by cats and other predators. Do not forget hummingbird feeders in the warmer seasons. Keep feeder areas clean.

Water source. Birds need fresh water throughout the year. They are particularly attracted to moving water. Water can be put into a birdbath or almost any other dish. Low-water-use birdbath drip systems are available from wildlife and bird supply dealers.

Shelter. Birds must feel safe before they will venture into new territory. Does your habitat have perching sites and hiding



White-throated sparrows like brush.

*See information sheets.

places on fence posts and in trees, bushes, tall grasses and wildflowers, and brush piles? If not, add shelter options for birds to use. (Discarded Christmas trees make excellent shelters.)

Nesting materials. From early spring through August, birds search for soft materials to add to their nests. You can bring birds into your habitat by displaying appealing biodegradable items for them to collect for their nests or for courtship displays.

Birdhouses. Buy or construct birdhouses that are appropriate for the birds in your community. Consult birding organizations or the local Audubon Society chapter for information specific to your area.

Step 1: Prepare for Observing Habitat Visitors

Design a wildlife log to record bird and other animal activity in your backyard or schoolyard habitat. Include date and time of observations, species description and identification, number of birds seen, behaviors, location and movement of birds in the habitat, and other observations.

Post this log in a safe indoor location that is close to a window where the feeders can be seen. Keep daily records of your observations. Train family members to assist when you are not at home.

Step 2: Set Up the Habitat

Construct two bird feeders in class, and select one or more types of seed. (See information sheets.) Take them to your habitat location and set them up. Add improvements that seem necessary and are appropriate for the season.

Step 3: Report Summary of Bird Activity

Organize your observations and research into a final presentation with the following sections.

A. Map of Habitat. Draw a detailed map of the study area that includes the location of all natural and human-made items useful to birds and other wildlife. (See sample habitat map on the Information Sheet.)

1. Show and label buildings, doors, trees, gardens, rocks, shrubs, fences, and adjacent roads or sidewalks, as well as

bird feeders, water sources, shelters, nesting materials, and birdhouses.
2. Include Title, Orientation, Date, Legend, and Scale (TODLS).
3. Write a description of the area to accompany the map. Include types of feeders, birdhouses, water sources, shelter, and nesting materials. Include drawings of the feeders and birdhouses. Explain where they are placed, how high they are off the ground, how far away they are from common disturbances such as doors, roads, and dog houses. Describe the types of food you have made available. Do not forget berry-producing bushes.

B. Past and Present Wildlife Use. Historical use of the area by wildlife could influence the kinds of animals that visit your habitat and the frequency of visits. In a chart, diagram, or paragraphs explain the history of wildlife habitation in your yard and neighborhood. Specifically, describe:
1. Birds and other animals that you have seen in your yard in the past.
2. Wildlife attractors (feeders, water sources, shelters, nesting materials, and birdhouses) that have been placed in the yard before this study.
3. Wildlife attractors in neighboring property.
4. The yard's closeness to open natural areas where birds and other animals may already live or visit.

C. Habitat Wildlife Field Guide. Using field guides and other informational sources, design a guide specific to the habitat. Draw and identify all species that visit, including squirrels, rabbits and other animals, as well as your birds. Explain in map, chart, or paragraph form the summer and winter range of each bird (or indicate that a bird is a year-round resident).

D. Habitat Food Web. Construct a web that begins with the food you have made available in the habitat. Show the birds and other animals that might feed on the different types of food, as well as any predators seen. If no predators were observed, hypothesize what types of animals might prey on the birds once they leave the safety of the habitat.
1. Color-code the levels of the food web (producers, herbivores, carnivores, omnivores, decomposers).

2. In a paragraph, explain which species you observed and which you did not. Explain why you decided not to observe certain species, such as a Cooper's hawk.

E. Observed Bird Behaviors. Choose at least two bird behaviors that you observed. Draw and describe each. Interpret why the birds behaved as they did. Possible behaviors include how and where the bird perches to eat from a feeder or feed its young, where it stays before or after feeding, and how birds interact when there are two or more birds at a feeder or perch site.

F. Suggested Improvements. Make three suggestions for increasing bird visitation in your habitat and three suggestions for improving your wildlife habitat in another season. For each improvement, tell (a) what you would do differently, (b) where you would make the change, and (c) which species of bird the change would attract.

Written and Oral Presentation

Include all of the above information in a written presentation using any of the following mediums:

- Booklet or journal
- Poster
- Hypercard or Hyperstudio computer software
- Videotape
- Other medium acceptable to the teacher

Prepare a three- to five-minute oral presentation that includes the following:

1. Your study site and the wildlife attractors you added.
2. Any historical information that influenced the results.
3. How you organized your data.
4. Wildlife that visited your study site.
5. One behavior observed.
6. One suggested improvement for winter and one for summer.

Presentation Checklist

- Cover page
- Purpose and procedure
- Wildlife log
- Food web
- Improvements
- Map
- History of use
- Field guide
- Observed behaviors

INFORMATION SHEET : LIFE PROJECT PART 2

Nesting Materials

From "Recycling for the Birds," by Cynthia Berger, *National Wildlife*, April/May, 1994, pp. 19–23.

Biodegradable items that make good nesting materials:

- Clothes dryer lint
- Short rag strips
- Cotton from medicine bottles
- Wool thread or yarn (old sweaters, socks)
- Short lengths of string (from potato and pet food bags)
- Feathers (from old pillow or down items)
- Raveled rope
- Dental floss
- Hair clippings (from people or pets)
- Vacuum cleaner dust

Nonbiodegradable materials that should not be put out:

- Fishing lines
- Fiberglass insulation
- Plastic bags or containers
- Nylon or polyester scraps

Simple Feeders

From Massachusetts Audubon Society, Lincoln, MA 01775, and Maryland Department of Natural Resources, Annapolis

Varieties of Plastic Jug Feeders

Pine Cones with Peanut Butter

Shelters

From Massachusetts Audubon Society, Lincoln, MA 01775, and Maryland Department of Natural Resources, Annapolis.

Birdhouse with Hinged Top

Wren House

Plastic Jug Birdhouse

Important: Different species require different-size entrance holes and house dimensions. Consult birdhouse-kit instructions.

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Resources

Books, Articles, Brochures

Berger, Cynthia. (1994, April/May). Recycling for the Birds. *National Wildlife*, 19–23.

Field guides to birds. Publishers include Golden Press, Houghton Mifflin (Peterson series), Knopf (Audubon Society guides), and National Geographic Society.

Forshaw, Joseph, Hawell, Steve, Lindsey, Terence, and Stallcup, Rich. (1994). *Birding*. Berkeley, CA: The Nature Company.

Knickerbocker, Brad. (1994, February 15). Stopping the Flight to Extinction. *Christian Science Monitor*, 10–11.

Line, Les. (1993, June). Silence of the Songbirds. *National Geographic, 183*(6), 68–91.

"Migratory Songbird Conservation." (1993). Washington, DC: U.S. Fish and Wildlife Service. (Brochure)

"Will We Lose Our Songbirds? Not If We Can Help It!" (1993). Washington, DC: National Fish and Wildlife Foundation. (Brochure)

Terborgh, John. (1992, May). Why American Songbirds Are Vanishing. *Scientific American, 266(5)*, 98–104.

Wille, Chris. (1994, November/December). The Birds and the Beans. *Audubon*, 58–64.

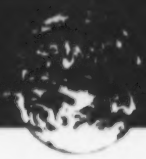
Wilson, E. O. (1989, September). Threats to Biodiversity. *Scientific American, 266(19)*, 108–116.

Sources of Information and Materials

American Backyard Bird Society, P.O. Box 10046, Rockville, MD 20849. Telephone: 301-984-9453.
- Send stamped, self-addressed long envelope for list of publications.

American Birding Association, Greg Butcher, President, P.O. Box 6599, Colorado Springs, CO 80934-6599. Telephone: 719-578-9703.

Cornell Lab of Ornithology, 159 Sapsucker Woods Road, Ithaca, NY 14850-1999. Telephone: 607-254-2421 (membership). Fax: 607-254-2415.
- Project FeederWatch. Add information about the birds at your feeder to Cornell Lab's North American Index of Species Abundance. Call 1-800-843-BIRD for a brochure or to sign up for $14 (credit card users only) or write to the lab. Participants receive *Birdscope* newsletter. e-mail: feederwatch@cornell.edu. For educator information, call the lab at 607-254-2440.
- "Common Feeder Birds" (posters, Eastern North America and Western North America, $2 each plus shipping and handling charge). Ask for Crow's Nest Birding Shop catalog, 607-254-2400.
- "Partners in Flight" slides (Eastern: $53.95 includes audio cassette; Western: $43.95, no audio cassette. Prices include postage. Send request to Visual Services.



International Migratory Bird Day, U.S. Fish and Wildlife Service, Office of Migratory Bird Management, 4401 North Fairfax Drive, Room 634, Arlington, VA 22203
• Organizer's Packet ($5.00).

Izaak Walton League,707 Conservation Lane, Gaithersburg, MD 20878.
Telephone: 1-800-284-4952.
• Save Our Streams Program

National Audubon Society, 666 Pennsylvania Avenue SE, Washington, DC 20003.
Telephone: 202-547-9009.
• Birds in the Balance Campaign. Contact your local or state chapter of National Audubon Society.

National Fish and Wildlife Foundation, 1120 Connecticut Avenue NW, Suite 900, Washington, DC 20036.
• Partners in Flight program to ensure the survival of the neotropical migrants, coordinating governmental and private organizations in Canada, the United States, Mexico, and Central America (free newsletter).
• "Neotropical Songbirds" and "Birds of Two Worlds" (posters, $10 for both, postage paid).

National Geographic Society, P.O. Box 2118, Washington, DC 20013-2118.
Telephone: 1-800-447-0647.
• Catalog sales: books, maps, videos, games, and other educational materials.

National Wildlife Federation, 1400 Sixteenth Street NW, Washington, DC 20036-2266.
Telephone: 202-797-6800 .
• Backyard Wildlife Habitat Program. Call 1-800-822-9919 for free information sheet on setting up habitats and application form for certifying backyards or schoolyards as national backyard habitats (certification costs $15). Also free, item 79605, "Invite wildlife to your backyard," reprint from August 1989 *National Wildlife*. Information packet of two booklets and application form (item 79919) costs $2 plus postage and handling.
• National Wildlife Week, third week in April, kits distributed by state affiliates.

Project WILD, 5430 Grosvenor Lane, Bethesda, MD 20814. Telephone: 301-493-5447.
• Schoolyard habitat guide, $5 postage paid.

Seiko Youth Challenge, c/o DRB Group, 20 Summer Street, Stamford, CT 06901-2304.
Telephone: 1-800-323-1550.

U.S. Fish and Wildlife Service, 1849 C Street NW, Washington, DC 20240.
• Partners for Wildlife. Contact the U.S. Fish and Wildlife Service Regional Office that works with your state. Address inquiries to "Partners for Wildlife Coordinator, U.S. Fish and Wildlife Service."

Wild Birds Unlimited. Stores across the nation. Telephone: 1-800-326-4928. (Franchise Headquarters, 3003 East 96th Street, Indianapolis, IN 46240.)
• Bird supplies and backyard bird habitat information.

NSTA
National Science Teachers Association
1840 Wilson Boulevard
Arlington, VA 22201
1 (800) 722-NSTA

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